



# Airspace Technology Demonstration 2 (ATD-2)

Tactical Surface Metering Briefing  
September 21, 2017

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- ATD-2 101 (General Briefing and Demo) May 5<sup>th</sup> 11AM–1PM EST
- ATD-2 101 (General Briefing and Demo) June 9<sup>th</sup> 11AM–1PM EST
- ATD-2 201 (Surface/TBFM Scheduling) July 20<sup>th</sup> 10–11:30 AM EST
- ATD-2 101 (General Briefing and Demo) Aug 3<sup>rd</sup> 10 – Noon EST
- ATD-2 201 (Surface ON time predictions, Runway assignments) Aug 24<sup>th</sup> 10:30–Noon EST
- ATD-2 301 (Fuser, SWIM Processing & Mediation, Matching) Sept 7<sup>th</sup> 10:30–Noon EST
- ATD-2 201 (Tactical Surface Metering) Sept 21<sup>st</sup> 10:30–Noon EST
- ATD-2 201 (Ramp Traffic Tools, Capabilities, Best Practices) Oct 12<sup>th</sup> 10:30–Noon EST
- ATD-2 101 (General Briefing, Field "go-live" status update) Oct 26<sup>th</sup> 10:30–Noon EST
- ATD-2 201 (Real-time Dashboard and Post Ops) Nov 9<sup>th</sup> 10:30–Noon EST
- ATD-2 201 (Metrics-Baseline, Current Reports, Data Analysis) Nov 30<sup>th</sup> 10:30–Noon EST
- ATD-2 201 (Understand & Process ATC Restrictions in the NAS) Dec 13<sup>th</sup> 10:30–Noon EST

- Keep broad group of ATD-2 stakeholders informed of progress in an inexpensive and unobtrusive manner
- Demonstrate actual system capability and lessons learned (as opposed to documents/plans)
- Take input from stakeholders that can be used to improve the ATD-2 system, processes and/or outreach
- Identify areas where more detailed discussion is desired/warranted

Go to [https://www.aviationsystemsdivision.arc.nasa.gov/research/tactical/atd2\\_remote\\_demos.shtml](https://www.aviationsystemsdivision.arc.nasa.gov/research/tactical/atd2_remote_demos.shtml) to learn about upcoming ATD-2 remote demos!

## ATD-2 Remote Demos

### To Join...

1. Go to: <https://ac.arc.nasa.gov/atd2/>  
Enter as a guest and type your name. NASA Employees can log-in with their email and password (NDC Credentials).
2. Dial the Telecon Number: **1-844-467-6272, Passcode: 592382#**

### Demo Objectives

- Keep broad group of ATD-2 stakeholders informed of progress in an inexpensive and unobtrusive manner
- Demonstrate actual system capability and lessons learned (as opposed to documents/plans)
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- Identify areas where more detailed discussion is desired/warranted

### Schedule

ATD-2 201 (Tactical Surface Metering)  
ATD-2 201 (Ramp Traffic Tools, Capabilities, Best Practices)  
ATD-2 101 (General Briefing, Field "go-live" status update)  
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Sept. 21st 10:30–Noon ET  
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Nov. 30th 10:30–Noon ET  
Dec. 13th 10:30–Noon ET

- The audio and video from this demo are being recorded



**RECORDING  
IN PROGRESS**

- Phase 1 Tactical Surface Metering Concept
- Phase 1 Tactical Scheduler Principles
- Phase 1 Tactical Scheduler Implementation
- Phase 1 Tactical Scheduler Use Cases & Challenges
- Post Phase 1 – Strategic Planning/Fusion
- Demo
- Q&A

- Phase 1 Tactical Surface Metering Concept
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- Thousands of hours of work from many organizations, over many years, contributed to the starting point for ATD-2 project
- Substantial contributions from
  - Surface CDM Team
  - TFDM Program Office
  - TBFM Program Office
  - NASA SARDA & PDRC projects
  - ... and more



Industry

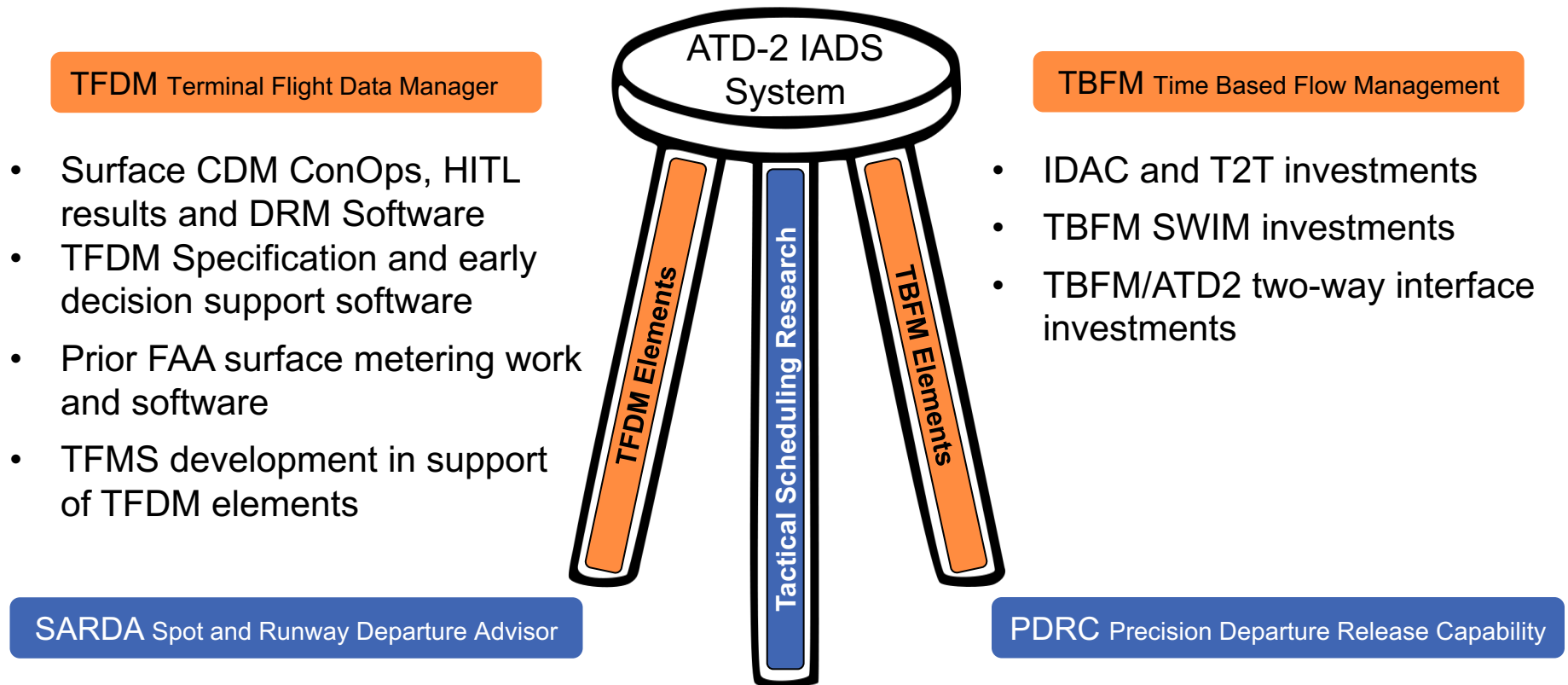


FAA



NASA

ATD-2 combines existing and emerging FAA technologies with technologies developed through NASA research to create an Integrated Arrival/Departure/Surface (IADS) traffic management system for the metroplex.



Prior NASA development work and software

ATC TMC Runway  
Utilization Intent



TRACON controller  
runway intent



Highly accurate  
TBFM de-conflicted  
ON time estimate



TFM SWIM ETAs



TIMs. Controlled Take  
Off Times (CTOT)



Carrier provided  
EOBTs



Tactical airline intent  
(ramp controller)



## Surface Predictive Engine

(Updates every 10 seconds)



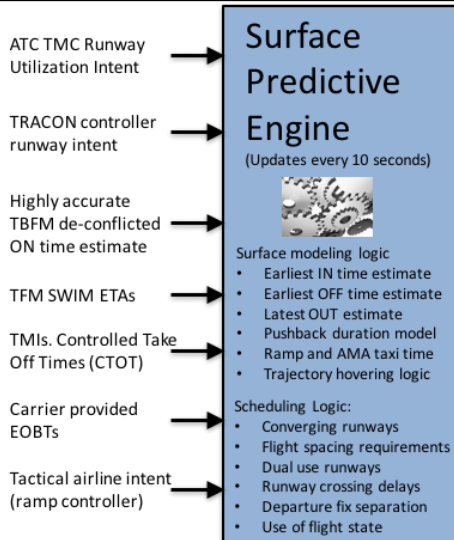
### Surface modeling logic

- Earliest IN time estimate
- Earliest OFF time estimate
- Latest OUT estimate
- Pushback duration model
- Ramp and AMA taxi time
- Trajectory hovering logic

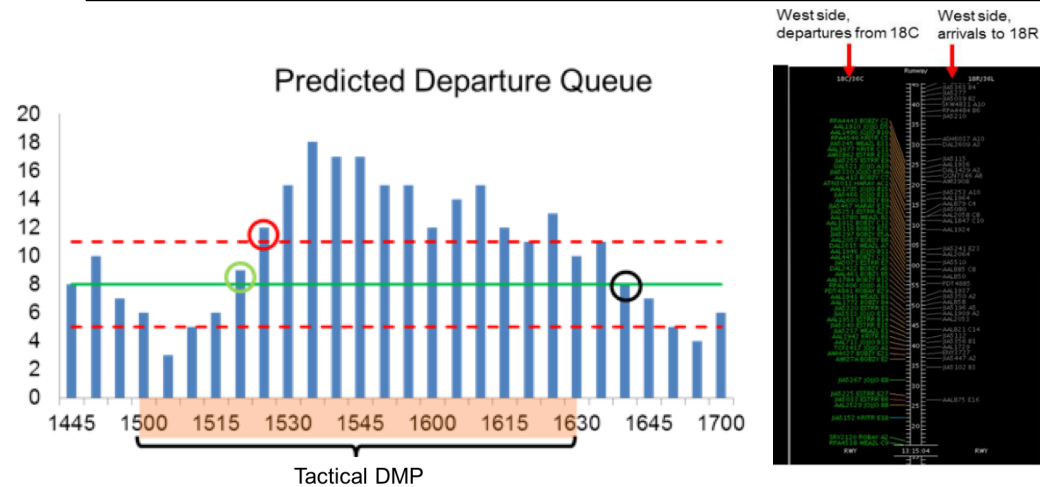
### Scheduling Logic:

- Converging runways
- Flight spacing requirements
- Dual use runways
- Runway crossing delays
- Departure fix separation
- Use of flight state

## 1 Generate Demand and Capacity Predictions



## 2 Monitor Surface Demand Capacity Imbalances



“What If” available. If Surface Metering, Go to Step 3

## 3 Enable Metering. Set Hold Level

**Time-Based Metering**

Set Target AMA Excess Queue Time:

- ☐ 14 minutes
- ☐ 12 minutes
- ☐ 10 minutes
- ☐ Other:  minutes.

Justification:

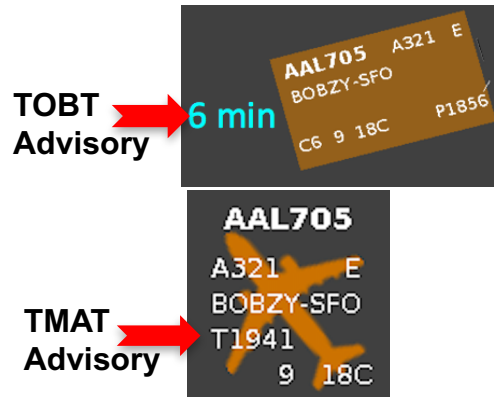
Metering Display Threshold:

Turn metering on when excess queue time rises to:  14 minutes.

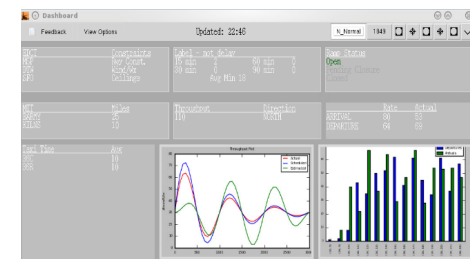
Turn metering off when excess queue time drops to:  10 minutes.

Apply Cancel

## 4 Honor TOBT and TMAI advisories

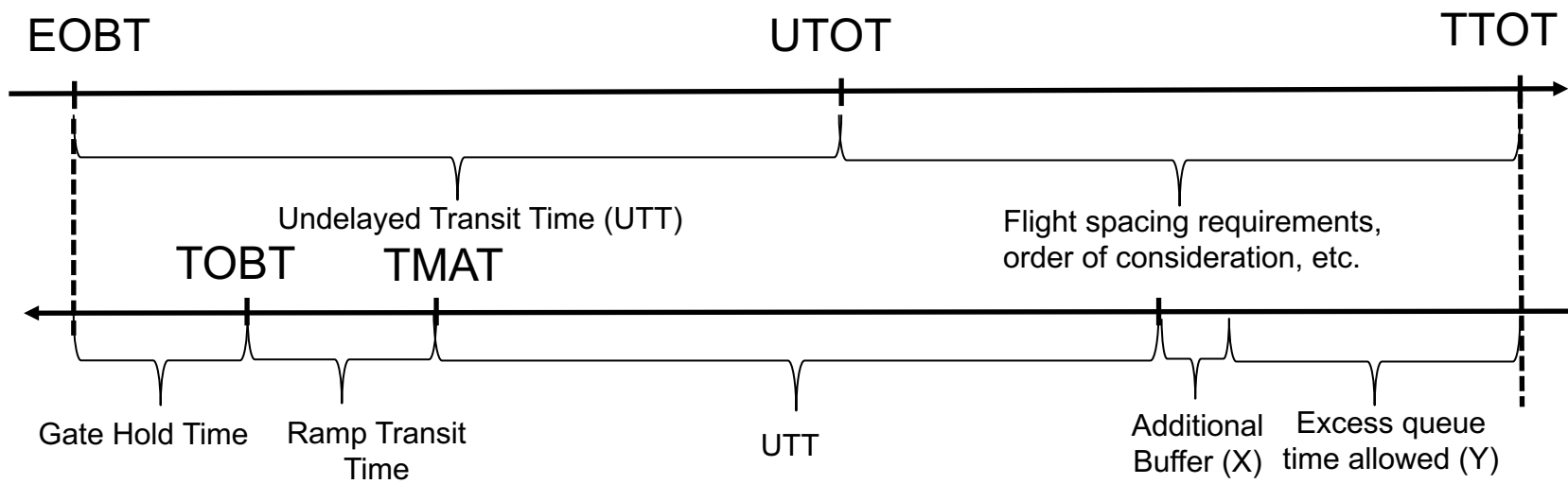


## 5 Evaluate Metering Effectiveness



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- SOBT – Scheduled Off-Block Time
- EOBT – Earliest Off-Block Time
- TOBT – Target Off-Block Time
- UTOT - Undelayed Takeoff Time
- TTOT – Target Takeoff Time
- TMAT – Target Movement Area entry Time



$$TOBT = \max (EOBT, TTOT - X*UTT - Y)$$

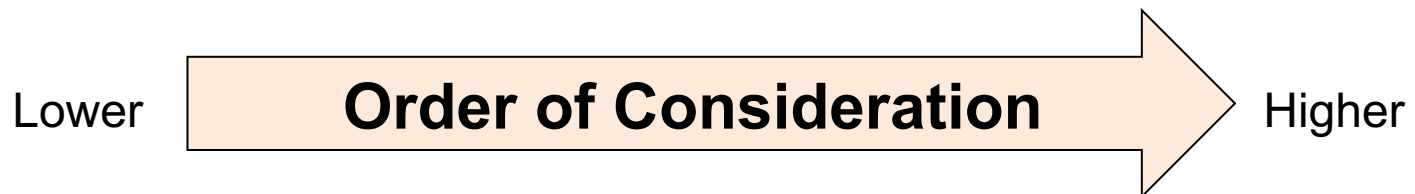
# Surface Scheduling: Order of Consideration



Uncertain	Planning	Ready	Out	Taxi	Queue
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Less accurate  
EOBTs or  
outside  
surface  
scheduling  
horizon

Accurate  
EOBTs and  
within  
surface  
scheduling  
horizon

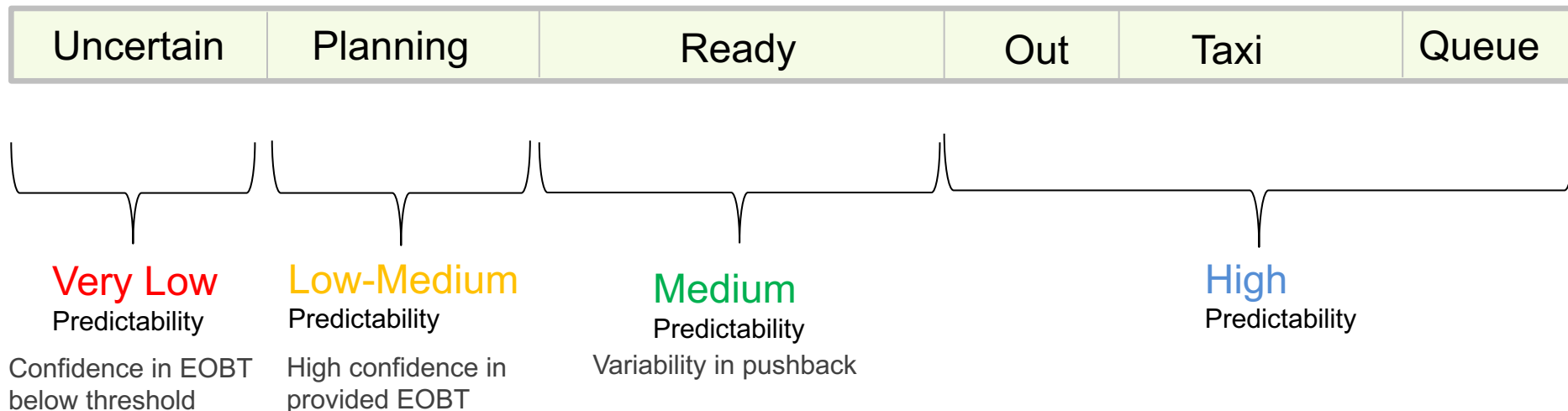


# Surface Scheduling: How Planning Group Fits In



## Planning group challenges:

- Planning is the most challenging category! FSFS used for flights in this group.
- **Without** a planning group to reserve some space, the tactical scheduler could only react to call in order. Thus, flights that call in 10 minutes ahead of scheduled time may take the slot of another flight *dutifully on time* (according to EOBT).
- **With** a planning group to reserve some space for flights that are dutifully on time and/or priority, pre-departure uncertainty may add unnecessary delay



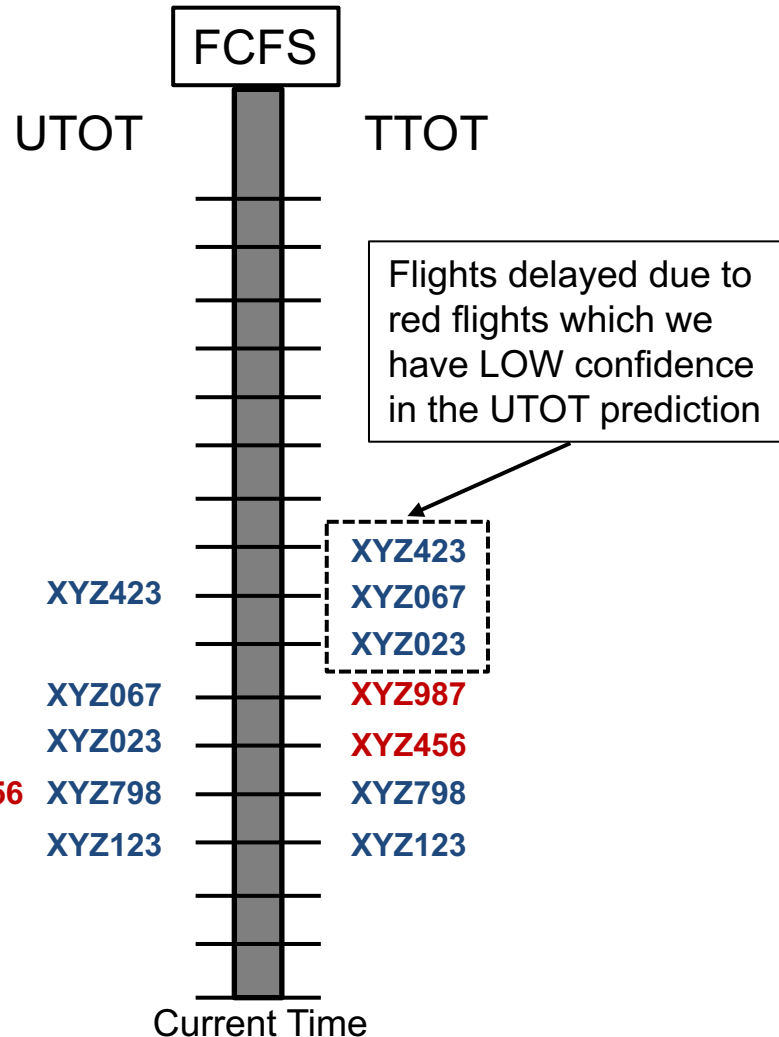
Inclusion/exclusion criteria for planning group membership is ongoing



= Planning (HIGH Confidence in UTOT)



= Uncertain (LOW Confidence in UTOT)

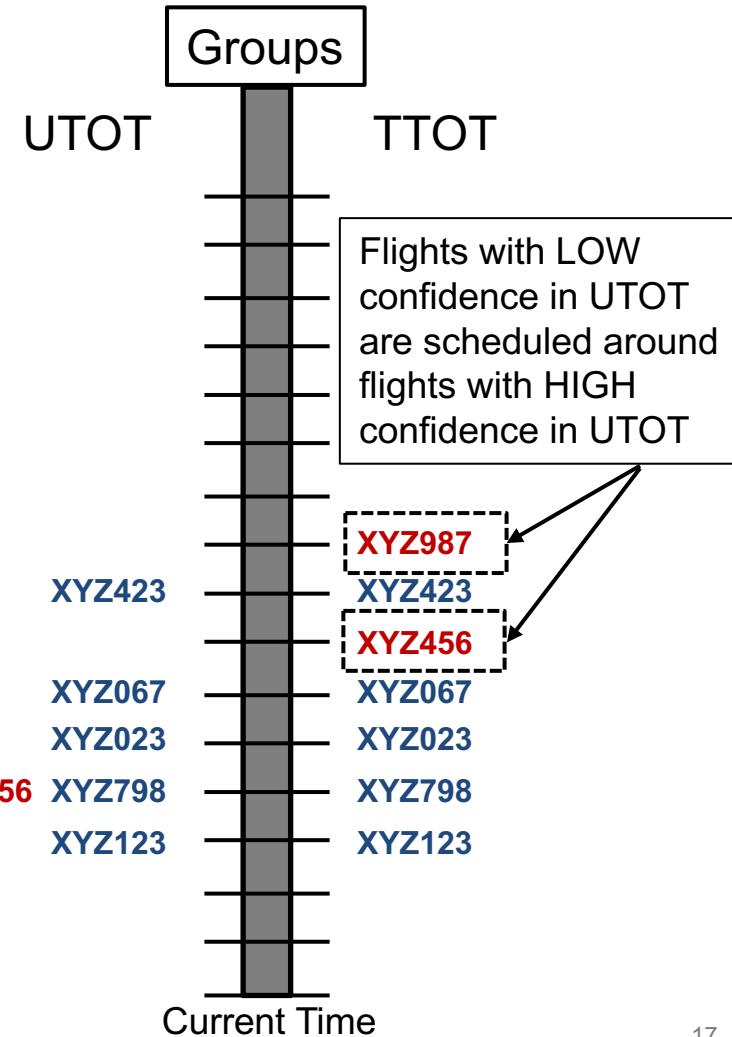
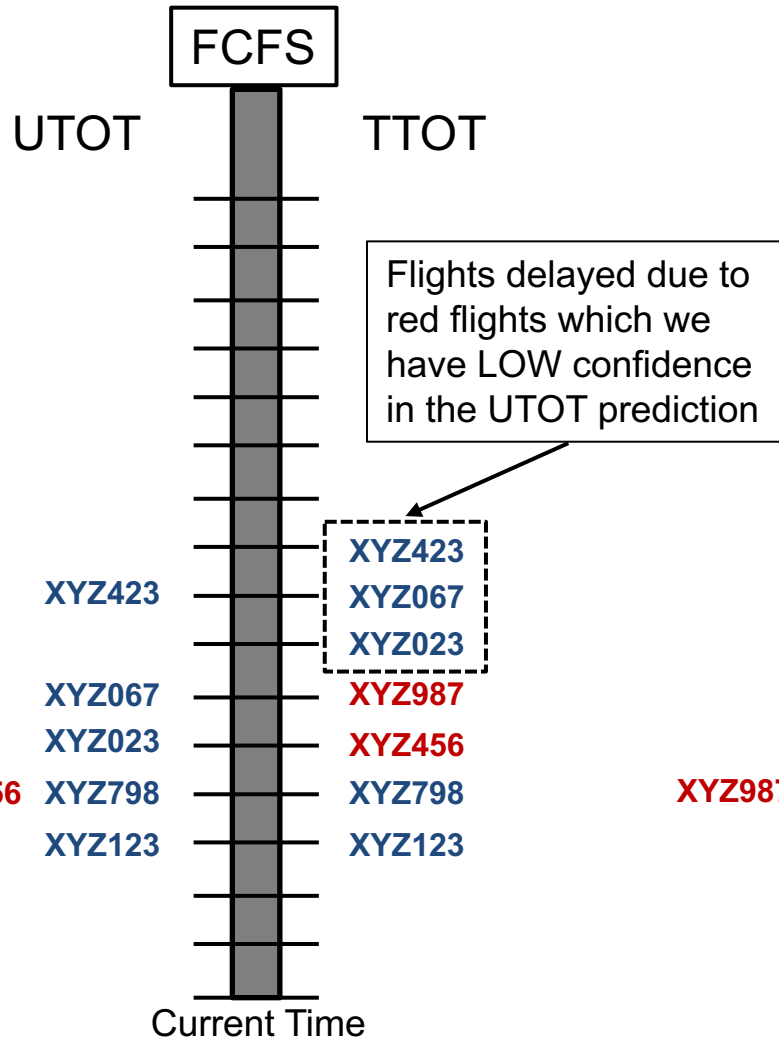




= Planning (HIGH Confidence in UTOT)



= Uncertain (LOW Confidence in UTOT)

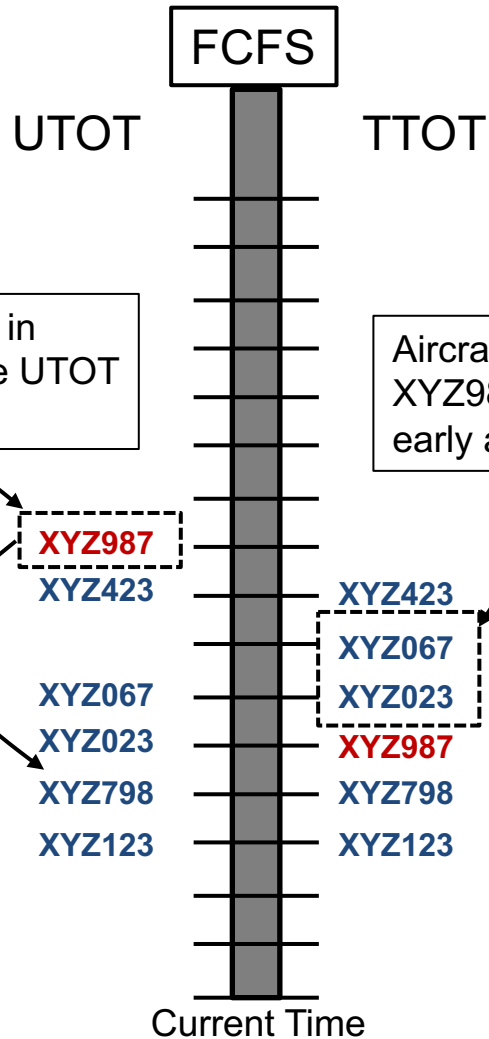




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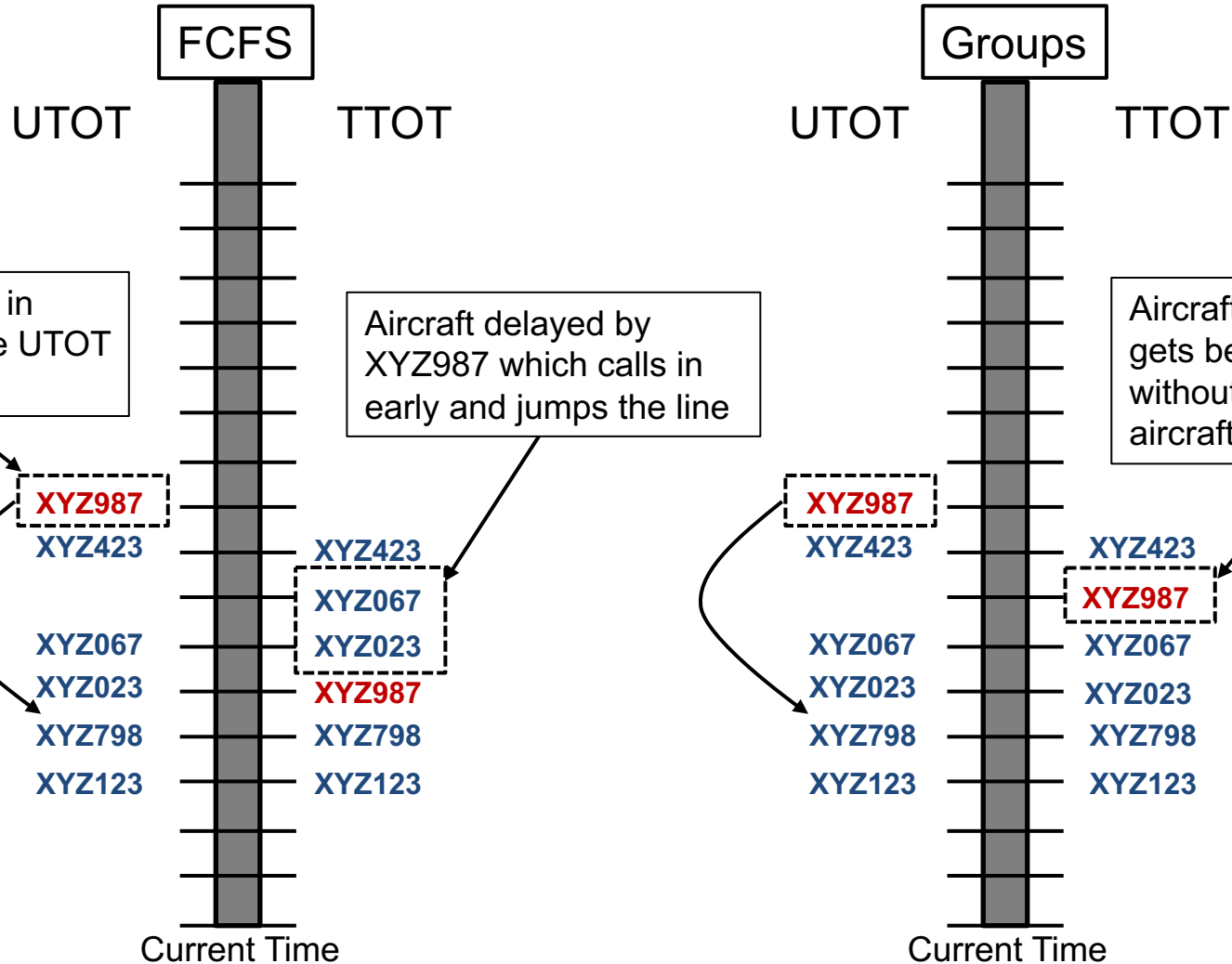




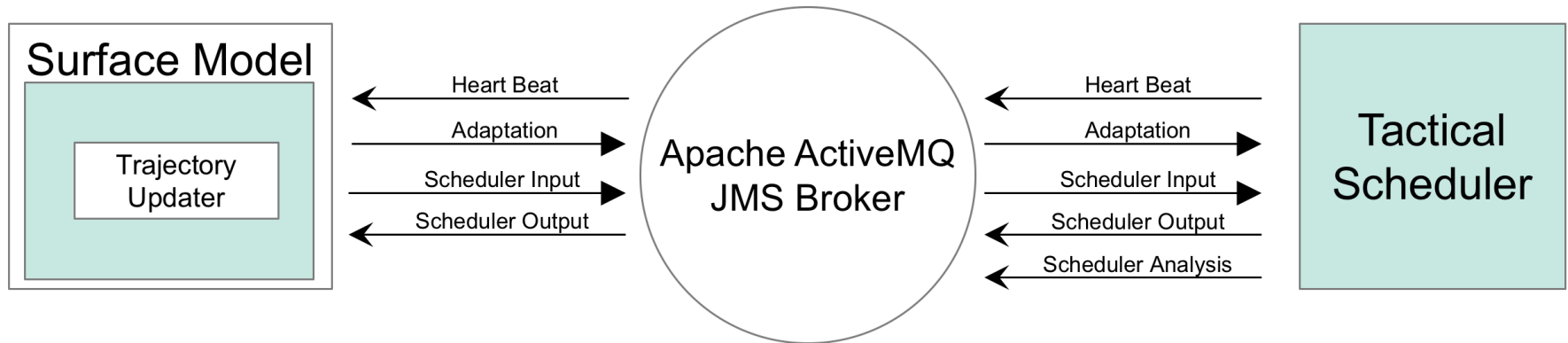
= Planning (HIGH Confidence in UTOT)



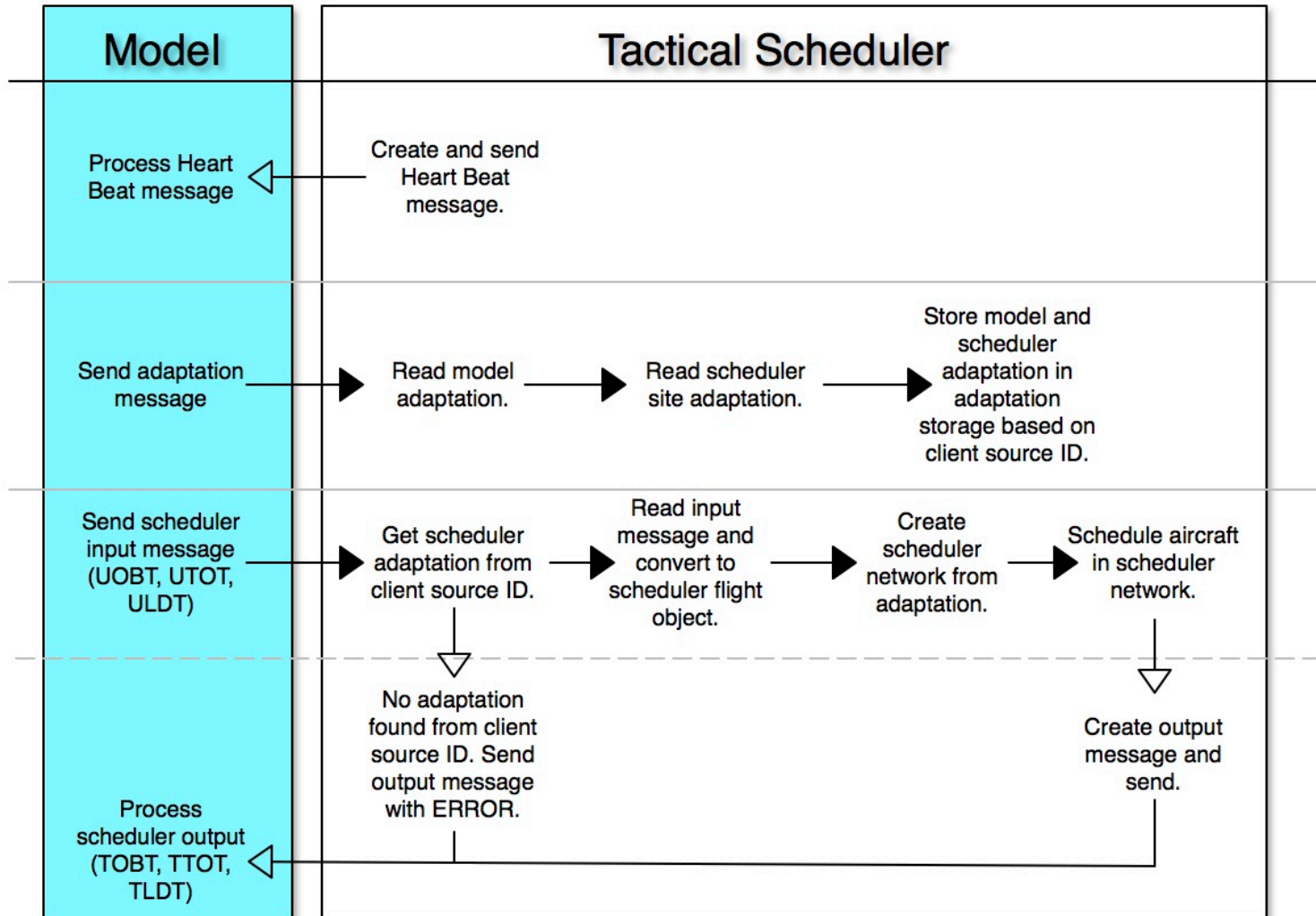
= Uncertain (LOW Confidence in UTOT)

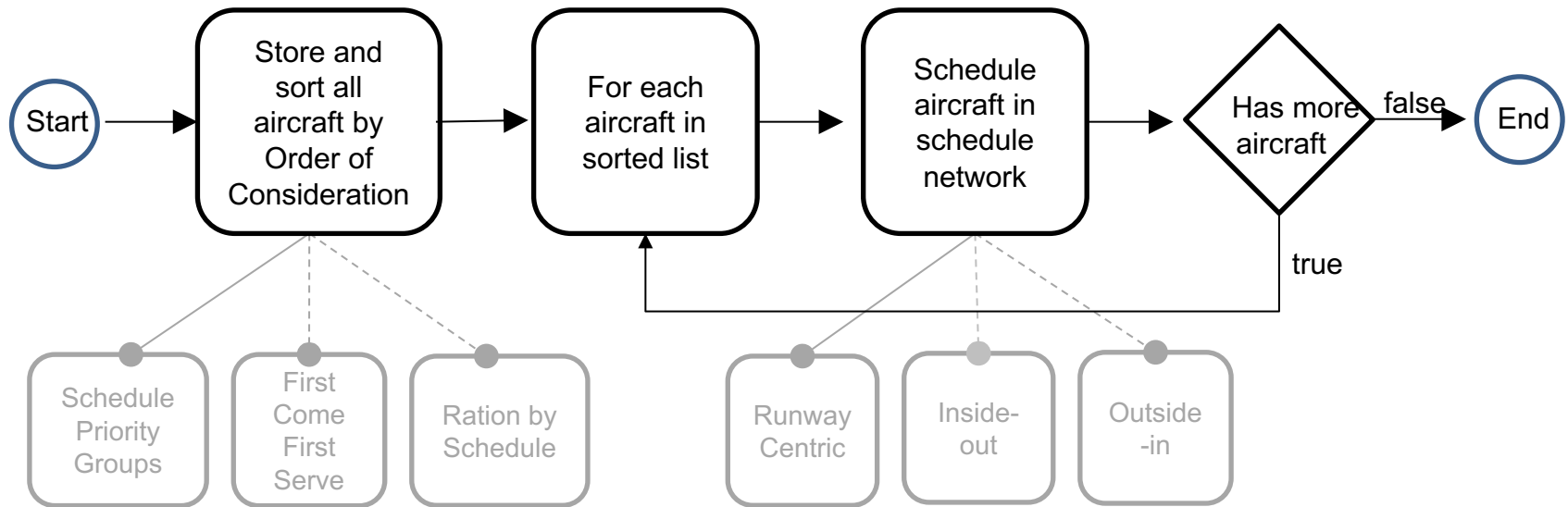


- Phase 1 Tactical Surface Metering Concept
- Phase 1 Tactical Scheduler Principles
- **Phase 1 Tactical Scheduler Implementation**
- Phase 1 Tactical Scheduler Use Cases & Challenges
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- Java application which communicates to the surface model through a JMS broker, using XML messages
- The surface model sends adaptation and input messages to the tactical scheduler for processing.





Note:

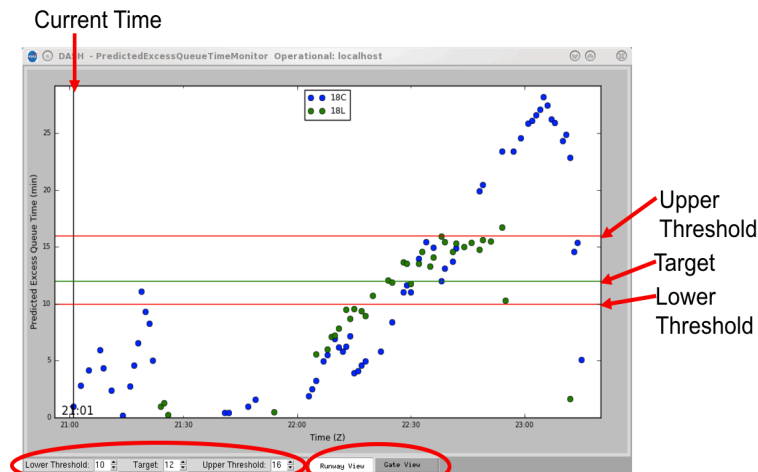
- ➔ Shows the data flow
- Modular functionality

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- Both Tower and Ramp managers monitor the prediction of excess queue time on dash board
- Ramp manager in coordination with ATC Tower turns on surface metering with target excess queue time and upper and lower thresholds

**DASH**

Predicted Excess Queue Time Graph  
Runway View



Enter proposed values for Lower Threshold, Target Queue Length, and Upper Threshold here

Choose Runway View or Gate View here

Surface Metering GUI for RMTC

- Planning group flights
  - Flights with accurate EOBTs and
  - Eligible flights enter Planning group 10 min prior to EOBT
  - RTC displays Push/Gate hold advisory
- Uncertain group flights
  - Flights with less accurate EOBTs or
  - Flights with accurate EOBTs, but outside scheduling horizon of the Planning group
  - RTC displays '#' for the ramp controller to click to obtain Push/Gate hold advisory

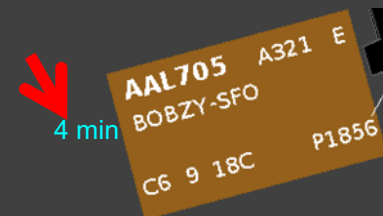
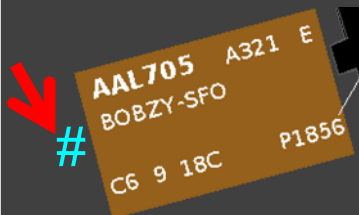
A: Hashtag

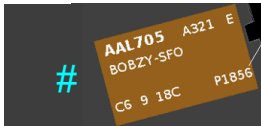



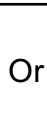
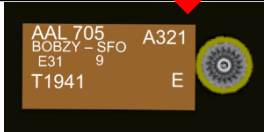
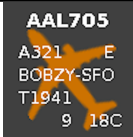

Or

B: Push advisory

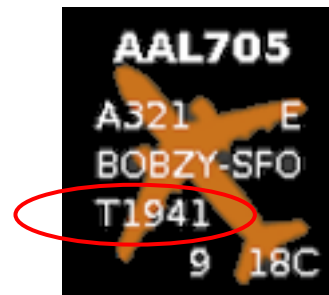
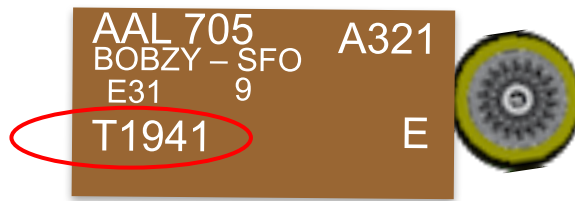
Or

C: hold n minutes:

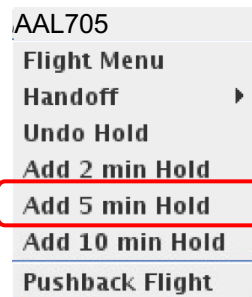


Metering Group	Definition	Ramp display
<b>Uncertain</b>	Flights with poor quality EOBT or (EOBT – current time) >10m	
<b>Planning</b>	Flights with high quality EOBT and within in 10 min of EOBT	 Or 
<b>Ready</b>	Flights that have called in ready for pushback	 Or 
<b>Out</b>	Flights that are in pushback state	
<b>Taxi</b>	Flights that are cleared for taxi or surveillance detects taxi	
<b>Queue</b>	Flights waiting in the runway queue	

- Ramp controller may want to push back aircraft earlier than its TOBT due to a gate conflict situation, and send to the hardstand or spot
- Ramp display shows TMAT on flight strip or aircraft icon to guide the ramp controller to meet the spot arrival time
- For the aircraft sent to the hardstand Ramp display alerts the ramp controller to communicate with the pilot



- Ramp controller may want to extend gate hold time for various reasons, e.g., alleyway blocked by a heavy jet
- Ramp controller can add extra hold time to prevent the flight from being placed into the Uncertain group



Arrival	APREQ	EDCT	Departure Taxi	Exempt	Ready	Planning	Uncertain
Flying	Gate and Taxi		Taxi	Gate			

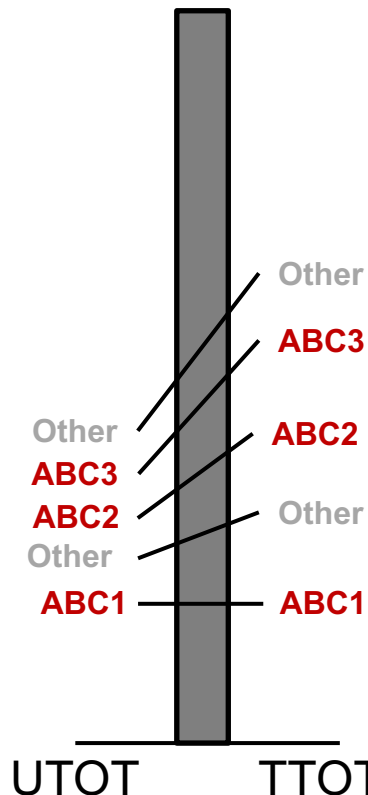
- FAA controlled flights have the highest precedence of departures.
  - APREQ flights are of higher precedence than EDCT flights
  - By scheduling with a higher order of consideration, a realistic view of the queue may not exist in the schedule when finding a de-conflicted runway time
    - To address this for APREQ flights without controlled release time, a queue prediction and EFTT buffer is added to the UTOT prior to de-conflicting with arrivals.
    - For EDCT and APREQ flights with a controlled release time, the TOBT/TMAT of the flight is modified to subtract the queue prediction and CTD buffer. This helps promote earlier pushback to encourage greater compliance to the FAA controlled time.
- The controlled flight category span flights on taxi and at the gate

Arrival	APREQ	EDCT	Departure Taxi	Exempt	Ready	Planning	Uncertain
Flying	Gate and Taxi		Taxi	Gate			

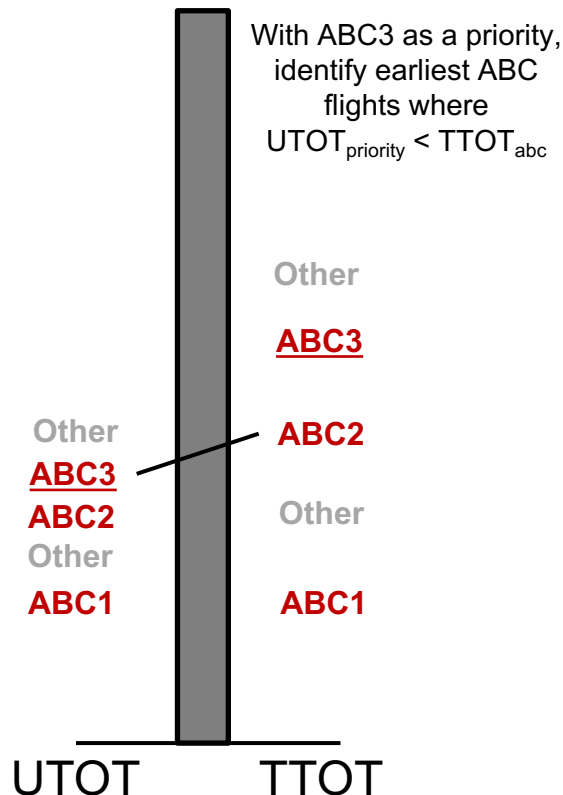
- Exempt flights are not subject to surface metering hold
  - TOBT = UOBT
- Of the departures at the gate, the exempt category ranks 3<sup>rd</sup> in the order of consideration.
  - Because of this, it is also possible that the schedule may not incorporate a valid queue length. Similar to APREQ flights, a predicted queue duration is added to the UTOT prior to de-conflicting the runway time.

- The goal of the algorithm is to opportunistically swap schedule sequences without changing other carrier schedule sequence.
- The priority algorithm is run for each airline carrier. The algorithm uses schedule sequence swaps which do not affect the sequencing of other carriers.

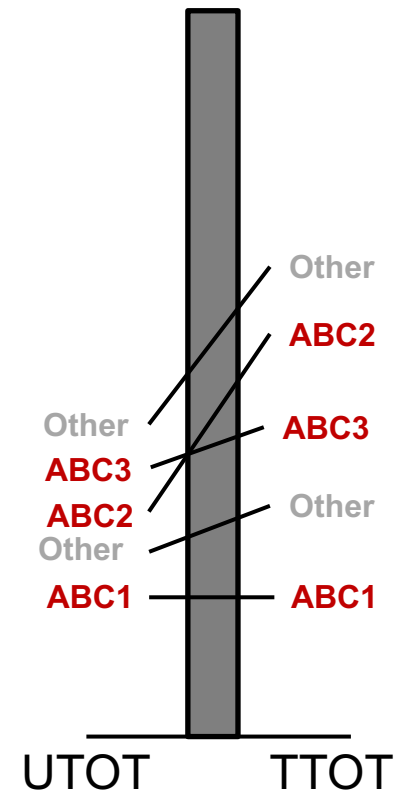
Pre-Priority Swap



Swap Attempt



Swap Result

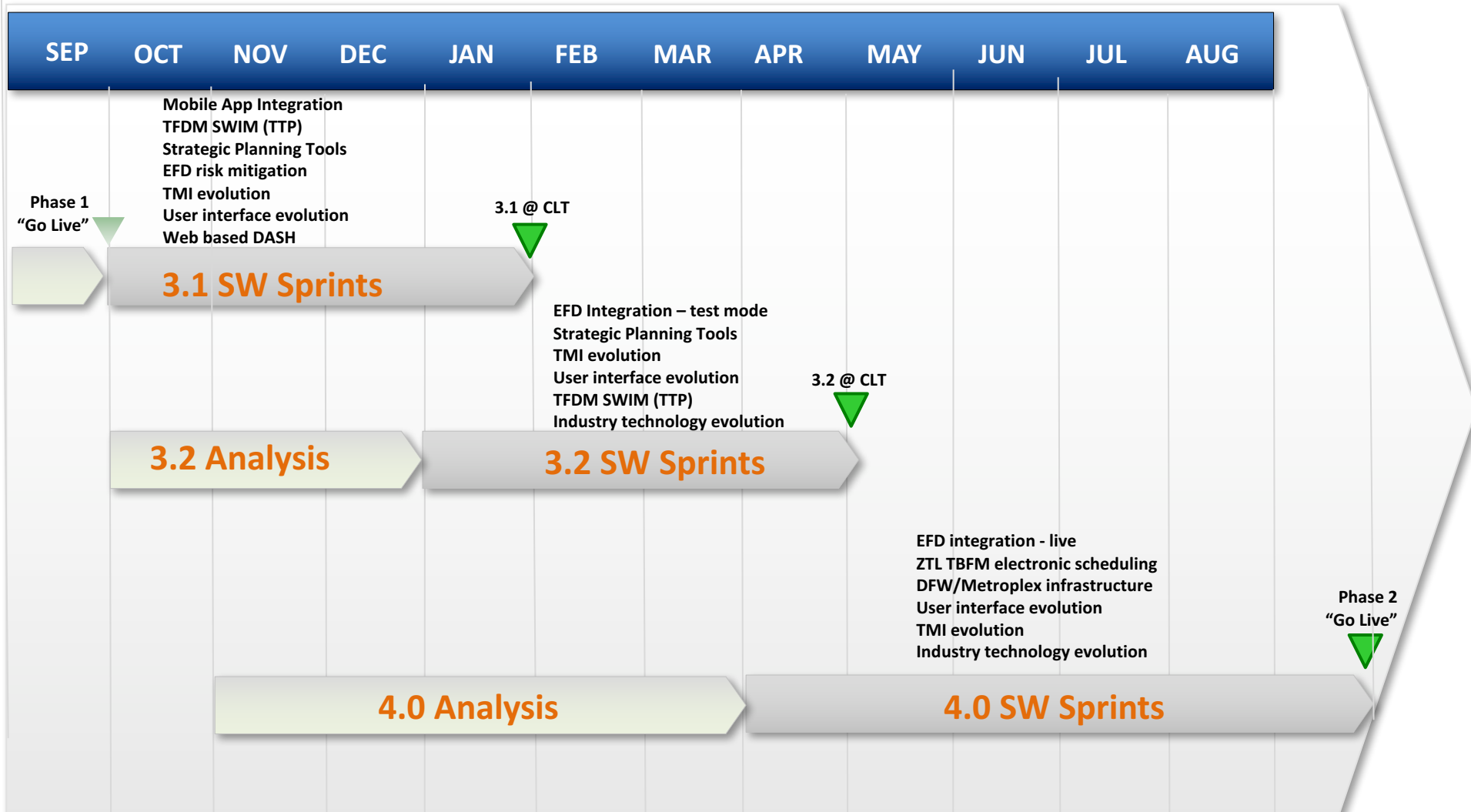


- Stability of TTOT and TOBT
  - Group hierarchy of order of consideration
  - Tight coupling between TTOT and TOBT via the delay propagation formula
- Uncertainty in surface operations and accuracy of UTOT prediction
  - EOBT uncertainty
  - Uncertainty in the duration of ramp area operations

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- Goals
  - Incorporate lessons learned from tactical scheduler during Phase 1
  - Incorporate additional concepts from Surface CDM for strategic timeframe and provide tech transfer benefits to TFDM
  - Provide planning tools on the strategic timeframe
    - Provide predictions at longer look-ahead times
    - Provide advanced notice of metering
    - Provide TOBTs and TMA Ts with more lead time
  - Continue to make use of tactical data, such as readiness information

- Strategic planning envisions (from S-CDM ConOps):
  - Accurate prediction of airport demand and capacity
  - Strategic management of airport surface traffic flows and departure runway queues
  - Management of surface arrival traffic flows that reflect known DMPs and predicted gate conflict information
  - Analysis, measurement, and monitoring capabilities for better understanding of local airport operational performance and the impact on the NAS
- Challenge in strategic planning is to produce accurate prediction of airport demand/capacity and queue prediction under significant uncertainties
- NASA integrated the FAA-developed Surface CDM HITL software with STBO (one way)
  - Result is two separate schedulers, tactical and strategic, with outputs that are not coordinated
- For Post-Phase 1, the goal is to run with a single fusion scheduler that seamlessly handles both timeframes



- Release 3.1 (Jan 2018 Go Live)
  - Demand/capacity forecast for longer look-ahead times
  - Advance notice of metering (DMPs)
  - Enhancement of tactical scheduler
  
- Release 3.2 (May 2018 Go Live)
  - Earlier assignment of TOBTs and TMA Ts incorporating RBS principles
  - Substitution mechanism for user-prioritization flexibility

- Initial planning phase
  - Developing specific use-cases and requirements
  - Investigating scope of software changes that are required to support changes
- Soliciting input from local users and national stakeholders in the near future

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- Questions?

**Thank you!**